

# Inner Coastal Plain Fish IBI



**John Vile**  
**Water Monitoring & Standards**  
**Bureau of Freshwater and Biological Monitoring**

# *What is a Fish Index of Biotic Integrity?*



- Using fish assemblages to assess the overall health of a stream ecosystem
- A scoring system based on multiple attributes (metrics) of a fish assemblage
- Individual metrics are summed and overall score used to determine health of a water body
- Metrics selected based on how well they indicate anthropogenic stressors



# *Why Use Fish as Biological Monitors?*



- Fish are long-lived and are therefore good indicators of long-term disturbances
- Fish assemblages generally consist of a number of trophic levels
- Fish are at the top of the food chain in aquatic environments and are consumed by humans
- Fish are easy to collect and identify
- Fish account for nearly half the endangered vertebrates of the U.S.

# *Validity of the Index of Biotic Integrity*

*Karr et al. 1986*

**Criterion 1.** *The measure must be biological.*

**Criterion 2.** *The measure must be interpretable at several trophic levels or provide a connection to other organisms not directly involved in the monitoring.*

**Criterion 3.** *The measure must be sensitive to the environmental conditions being monitored.*

**Criterion 4.** *The response range of the measure must be suitable for the intended application.*

**Criterion 5.** *The measure must be reproducible and precise within defined and acceptable limits for data collected over space and time.*

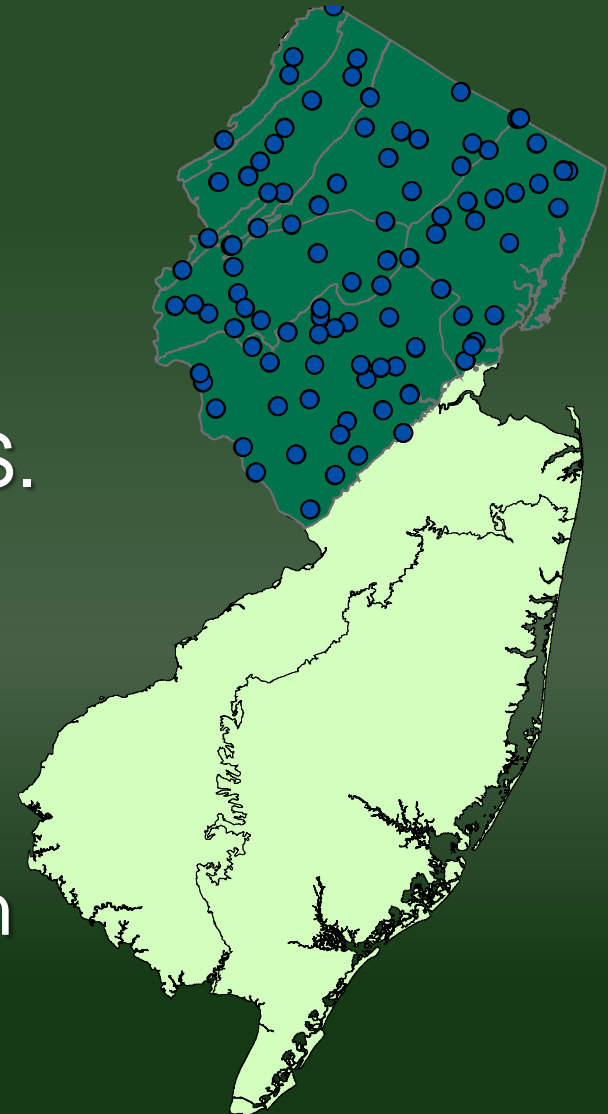
**Criterion 6.** *Variability of the measure must be low.*

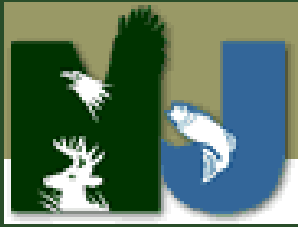


# Northern Fish IBI



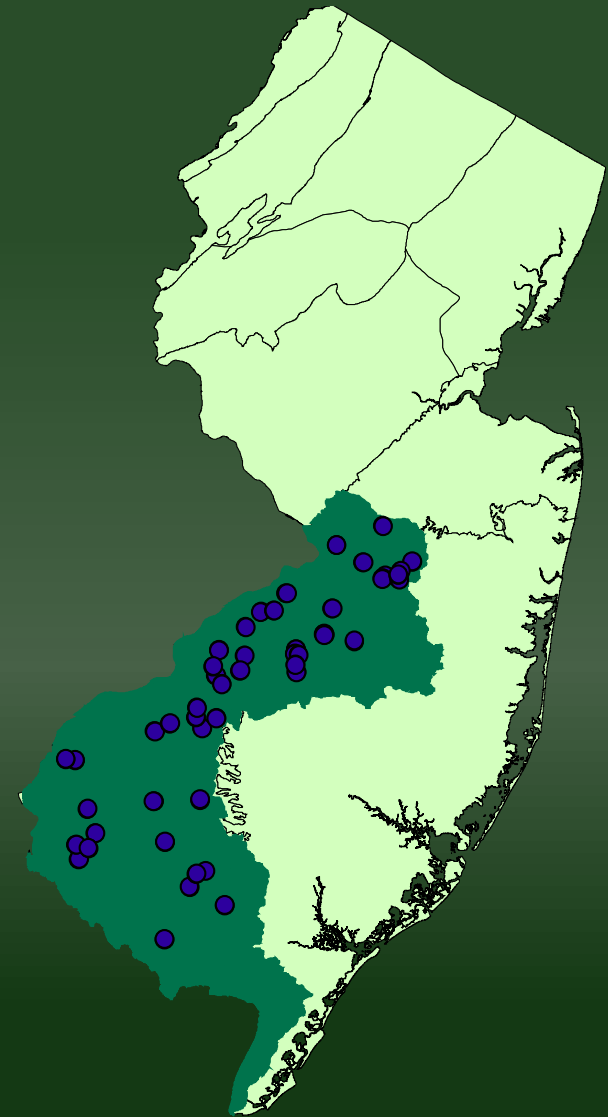
- Northern Fish IBI developed by U.S. EPA Region 2
- BFBM initiated monitoring in 2000
- 98 site network consisting of fixed, random, sentinel sites
- 26-32 sites per year, 5 year rotation
- Index period – June through Mid-October
- Currently in 3rd round of monitoring





# *Southern Fish IBI*

- Pilot project to develop a fish IBI started by NJ Fish & Wildlife in 2000
- BFBM initiated redevelopment in 2008
- Scoring criteria and validation finalized spring 2012
- 43 site network consisting of fixed, random, sentinel sites





# *North vs. South*



## Northern Streams

- High gradient
- Cobble/boulder
- Riffle/run/pool
- More diverse



## Southern Streams

- Low gradient
- Sand/gravel
- Run/pool
- Lower diversity



# Methods

## Backpack Electrofishing



## Barge Electrofishing





# *Healthy Fish Community*





# *Impaired Fish Community*



Mummichog



Banded Killifish



Green Sunfish



White Sucker





# *Southern IBI Development*



- Used Maryland, Virginia, North Carolina, South Carolina, and Georgia Programs as models for developing NJ Inner Coastal Plain Fish IBI
- All of these states have similar fish species to NJ
- Maryland has an established Coastal Plain Fish IBI and has completed recalibration
- Results present to MD DNR, EPA Regions 2 and 3, Versar Inc, and NJ Fish IBI Workgroup

# Steps

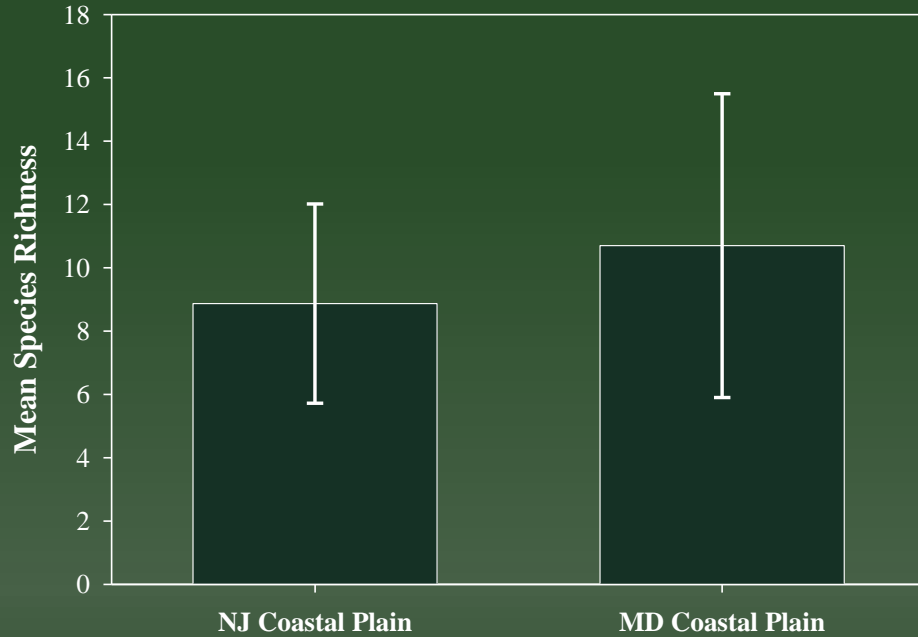


- Researched historical fish distributions within Inner Coastal Plain
- Identified and sampled “least impacted” and “most impacted” sites within Inner Coastal Plain
- Researched applicability of Coastal Plain Fish IBI’s from other states
- Used Maryland DNR Coastal Plain Fish IBI as a template for data analysis and metric development
- Tested Coastal Plain metrics, Northern NJ IBI metrics, and Karr’s original fish metrics

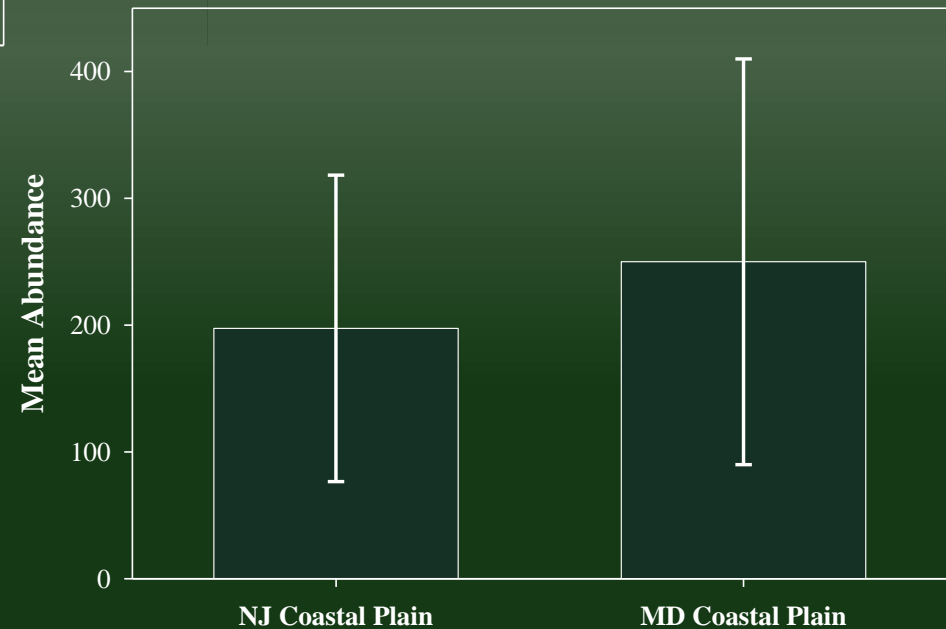


# *New Jersey vs. Maryland*

**Native Species Richness**



**Mean Number of Individuals**



# *Analysis*



- 111 sites were sampled for development including 21 least impaired and 24 most impaired sites
- Completed n-1 Jackknife validation
- Completed n-10 Bootstrapping validation
- Evaluated minimum drainage size
- Completed evaluation of different scoring techniques
- Completed network design to include fixed, sentinel, and probabilistic sites



# *Southern IBI Metrics*

## **Richness & Composition**

1. Native Species Richness
2. Benthic Species Richness
3. Intolerant Species Richness
4. Proportional Abundance Tolerant Species

## **Trophic Composition**

5. Proportional Abundance Insectivores
6. Proportional Abundance Piscivores

## **Fish Abundance & Condition**

7. Abundance minus Tolerant Species
8. DELT Anomalies

# *Impact Classification*

Condition	Least Impacted N=21	Most Impacted N=24
%Forest/Wetland	>50%	<35%
%Urban	<20%	>60%
%Impervious Cover	<5%	>19%
pH	>5.5	None
Instream Habitat	Optimal or Sub-optimal	None
Fish Abundance	>100	None
Fish Richness	>5	None



# Results of Metric Testing

*Mann-Whitney (M-W)*

*Kolmogorov-Smirnov (K-S)*

	Reference n = 21 Impaired n = 24		Pearson Correlation n = 111	
Metric	M-W	K-S	Urban	Forest
Native Sp.	<b><math>P &lt; 0.001</math></b>	<b><math>P &lt; 0.001</math></b>	<b>-0.29</b>	<b>0.39</b>
Benthic Sp.	<b><math>P &lt; 0.001</math></b>	<b><math>P &lt; 0.001</math></b>	<b>-0.48</b>	<b>0.35</b>
Intolerant Sp.	<b><math>P &lt; 0.001</math></b>	<b><math>P &lt; 0.001</math></b>	<b>-0.41</b>	<b>0.46</b>
% Tolerants	<b><math>P &lt; 0.001</math></b>	<b><math>P = 0.001</math></b>	<b>0.47</b>	<b>-0.27</b>
% Insectivores	<b><math>P &lt; 0.001</math></b>	<b><math>P &lt; 0.001</math></b>	<b>-0.48</b>	<b>0.30</b>
% Piscivores	<b><math>P = 0.002</math></b>	<b><math>P = 0.001</math></b>	<b>-0.18</b>	<b>0.24</b>
Abundance	<b><math>P &lt; 0.001</math></b>	<b><math>P = 0.001</math></b>	<b>-0.21</b>	<b>0.07</b>

# *Benthic Species Richness*

- Includes the following species:  
Sea Lamprey, American Brook Lamprey,  
Margined Madtom, Creek Chubsucker,  
Tadpole Madtom, Swamp Darter,  
Tessellated Darter, and Yellow Perch





# *% Abundance of Tolerant Species*

- Includes the following species:  
American Eel, Green Sunfish, Bluegill, Banded Killifish, White Sucker, and Mummichog



# *% Piscivorous Species*

- Includes the following species:  
White Perch, Redfin Pickerel, Chain Pickerel,  
Striped Bass, Black Crappie, Largemouth Bass,  
and Yellow Perch





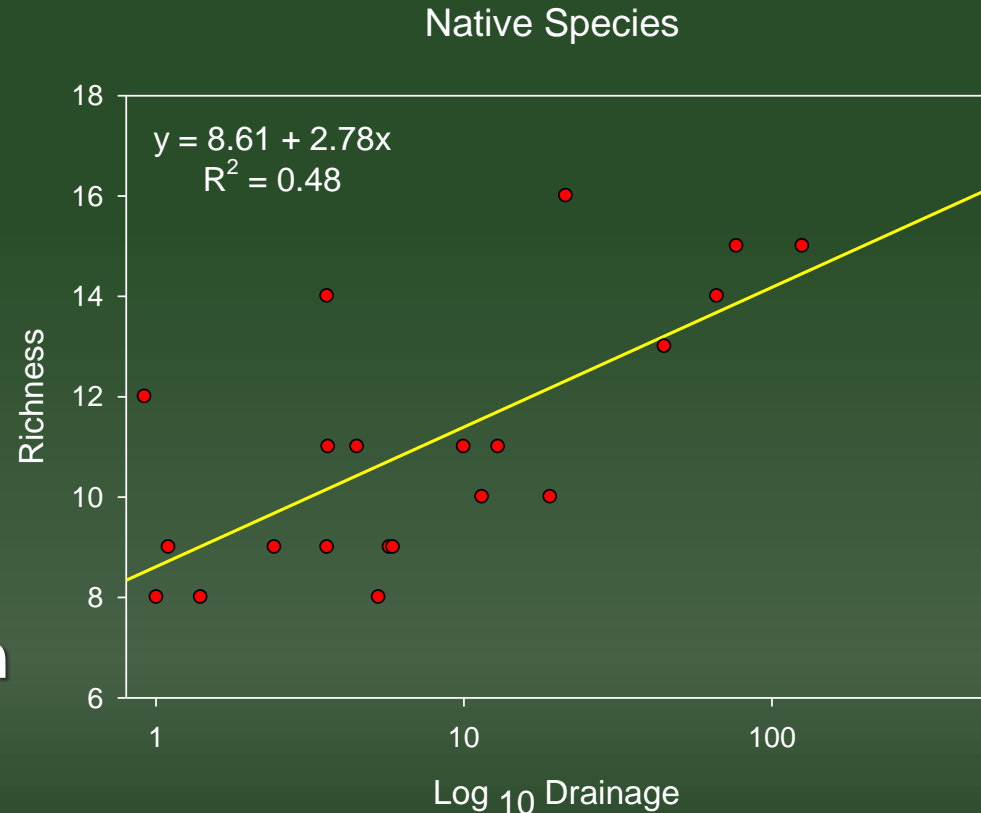
# *% DELT Anomalies*

- Based solely on BFBM data



# Metric Scoring

- Metrics adjustments determined by Pearson correlations ( $p < 0.05$ ) and by exhibiting strong linear relationship with drainage area ( $R^2 > 0.25$ )
- Metrics exhibiting a strong relationship with drainage area were adjusted using the following equation:



*Adjusted value = mean reference + observed – predicted (Tetra Tech, Inc.)*

*Where predicted value =  $m * \log_{10}(\text{drainage area in } m^2) + b$*



# Metric Scoring Criteria

## Richness & Composition

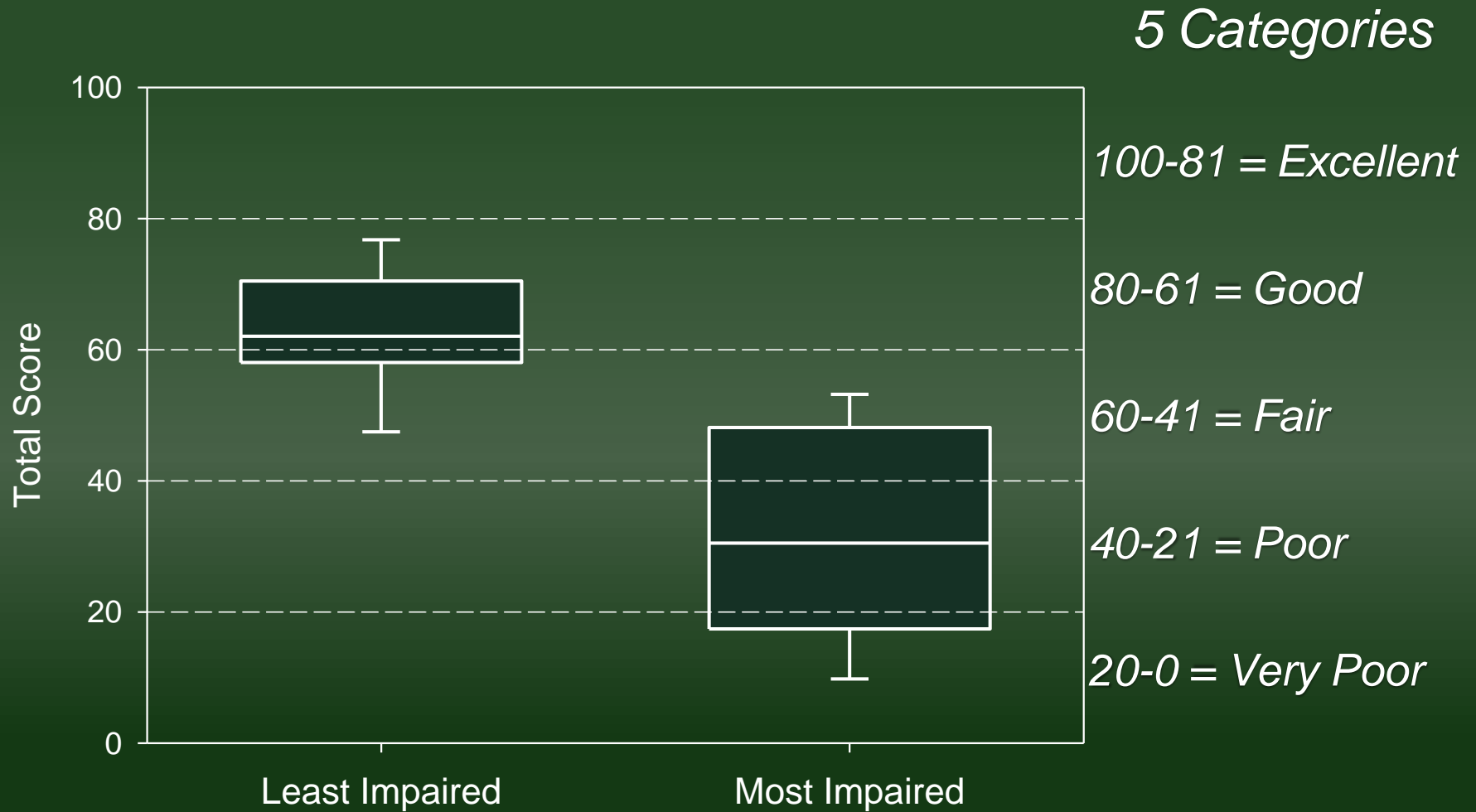
Number of Native Species  $11.05 + x - [\text{Log}_{10}(\text{Drainage Area} * 2.7828) + 8.6142]$

Number of Benthic Insectivores  $2.29 + x - [\text{Log}_{10}(\text{Drainage Area} * 0.6293) + 1.7354]$

Number of Intolerant Species  $1.38 + x - [\text{Log}_{10}(\text{Drainage Area} * 0.7737) + 0.7043]$

Metric	Coefficient of Variability	Discrimination Efficiency	Response	Scoring
Native Richness	16.6	87.5%	↑	$100 * X / 15$
Benthic Richness	19.8	83.3%	↑	$100 * X / 3$
Intolerant Richness	44.3	91.7%	↑	$100 * X / 2$
% Tolerants	24.4	70.8%	↓	$100 * (93.5 - X) / 93.5$
% Insectivores	35.0	83.3%	↑	$100 * X / 61.2$
% Piscivores	126.9	70.8%	↑	$100 * X / 31.8$
Abundance	39.4	75.0%	↑	$100 * X / 299$
DELTs	32.3	46.2%	↓	$100 * (3.4 - X) / 3.4$

# *Rating Categories*





# Case Study

## FIBI213 Ivanhoe Brook

- 66% Forest/Wetland
- 13% Urban
- 3.5% Impervious Cover
- 3.6 Miles<sup>2</sup> Drainage
- Habitat score = 134
- IBI score = 77 Good

## Results

- 14 Native Species
- 4 Benthic Insectivores
- 2 Intolerant Species
- 20% Tolerant Species
- 51% Insectivore Species
- 4% Top Predator Species
- 132 Fish
- 0% External Deformities



# Case Study

## FIBI201 NB Pennsauken Creek

- 31% Forest/Wetland
- 60% Urban
- 19% Impervious Cover
- 4.0 Miles<sup>2</sup> Drainage
- Habitat score = 98
- IBI score = 36 Poor

## Results

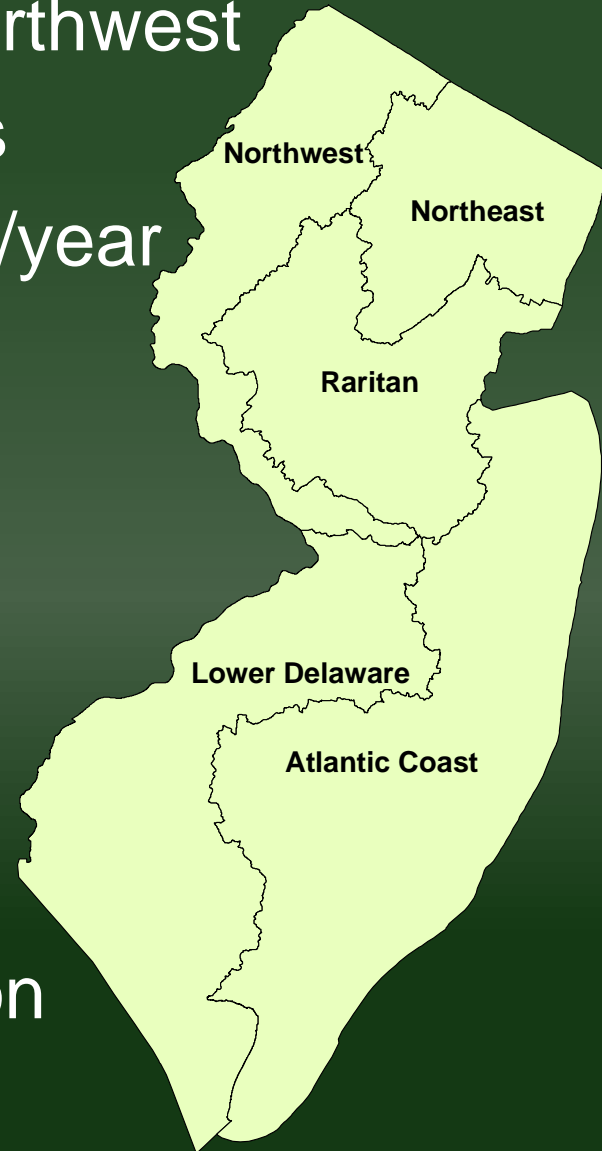
- 8 Native Species
- 1 Benthic Insectivores
- 0 Intolerant Species
- 56% Tolerant Species
- 5% Insectivore Species
- 1.5% Top Predator Species
- 88 Fish
- 0% External Deformities





# *Southern IBI Network*

- Regional sampling – 2012 N.IBI Northwest
- 26 S. IBI Fixed sites – every 5 years
- 15 S. IBI Probabilistic sites – 3 sites/year
- 2 S. IBI Sentinel sites – 1 site/year
- Atlantic drainage streams will be evaluated during Atlantic Coastal Plain Monitoring
- If S. IBI is applicable to Atlantic drainage streams, 9 additional fixed sites will be added in this region





**Any  
Questions?**

